The Ethics of Mixed Reality Games

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Mixed Reality (MR) Games integrate digital elements with real world places. In doing so they change those places, with important ethical implications. We present a synthesis of 8 existing frameworks on MR Ethics to establish a set of ethical issues for MR Games, and a qualitative analysis of interviews with 17 MR Game Designers to define the strategic approaches they use to address them. We identify 26 ethical issues over 5 dimensions: Claim Rights, Duty of Care, Social Justice, Privacy, and Control; and 59 separate tactics forming 13 strategic approaches over three areas: Design, Participant Management, and Logistics. Mapping these to codes of ethics from the ACM and IEEE we show that the strategies can be seen as methods for behaving ethically within the context of MR Game development, although many strategies rest on the virtues of individual designers and their critical engagement with an ongoing ethical process.

CCS Concepts: • **Software and its engineering → Interactive games**; • **Social and professional topics → Codes of ethics**; • **Human-centered computing → Mixed / augmented reality**.

Additional Key Words and Phrases: mixed reality, ethical issues, ethical strategies

1 Introduction

Augmented and Mixed Reality Games (we use the term Mixed Reality (MR) for brevity)[1] augment real spaces with digital information, and introduce interactions that cross between the real and the digital.

[1]For a full discussion of terminology please see Section 2.1.

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ACM 2832-5516/2024/7-ART
https://doi.org/10.1145/3675806

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They come under a range of guises. Digital tour guides were amongst the first MR systems to appear [12][52][26]), guiding users around a physical place and providing additional digital information on what they see around them. Locative Literature [53] or Ambient Literature [27] extends this into coherent narratives, situated stories that either change depending on where you read them, or are read by navigating through a series of physical locations that each trigger new content. This might be a linear experience, but the player (or reader) can also be given agency, making interactive narrative choices by physically moving to alternative locations [36]. The content might be text and images, but more complex media is also possible, such as audio [17], superimposed video [85], or 3D models aligned to the real world [57].

MR Games go beyond these narrative elements, and extend this interaction with a wider variety of mechanics, such as treasure hunting or chasing other players [46]. Commercial companies producing Mixed Reality Games include Niantic (*Pokemon Go!*, *Harry Potter: Wizards Unite!*) and Six to Start (*Wanderlust*, *Zombies Run!*), but there are also a host of examples from the academic world, typically focused on heritage applications using Mixed Reality Games to drive interactions with cultural sites [20][21][14] (and see Section 2.2 for additional examples).

Designers have known for a while that there are ethical concerns around mixed reality games. Pokemon Go! in particular has hit the headlines for (initially) allowing players to play the game at any location, including sacred and sensitive sites.[2] Concerns have also been raised about the safety of distracted players [22].

Despite being a poster child for mixed reality problems there is nothing inherently unethical about Pokemon Go! but its large player base and relatively long life have made it a minesweeper for ethical issues. Just as the Web, Social Media, and AI have led to unintended consequences for society, so too will the rise in locative games and mixed reality [65]. After all technology mediates space, and is involved with 'place making' or the way in which space and place are enacted [24], and the current generation of locative tools (such as located social media posts, or online reviews of businesses) already exert different types of power over place [97].

There are frameworks for designing and developing mixed reality games, but they do not have an ethical focus, and few contain any ethical considerations at all, concentrating instead on the software engineering process [92], practical design issues [45], or design best practices [71].

As a group of researchers engaged with designing and developing MR experiences ourselves we are very aware of this lack of guidance. Since the early 2000s we have been engaged in a range of projects working directly and indirectly with cultural heritage organisations and the public to design, deploy, and evaluate MR games. However, many of us also work in the web and social media space, and have seen the enormous consequences of that technology on society, where it challenges our notions of privacy in the West [69], has led to mass surveillance in the East [50], and caused some to declare the dawn of a post-truth world [59]. When faced with these enormous unintended consequences, we are left asking ourselves where might our own research in MR games lead, especially as the field moves from rare academic examples to more accessible and popular commercial platforms.

This concern motivates our exploration of the ethics of MR games, but it also means we take a particular perspective. Our backgrounds are in HCI, but our educational and professional foundations are primarily in engineering, with a focus on empirical experimentation within the ethical frameworks of organisations such as the ACM. Similarly, our work has typically been in a European context, with European notions of authorised heritage, and Western conceptions of public and private spaces, property and ownership [2]. While we have attempted in our methods to gather broad perspectives, we also embrace our own experiences as a way to contextualise our analysis.

In this paper we thus tackle the absence of ethical frameworks for MR Games in the hope of contributing to future frameworks, but with the acceptance that our view is influenced by our European context and our own

[2]Brian Feldman (July, 2016) Yes, You Can Catch Pokemon at Auschwitz, New York Magazine http://nymag.com/intelligencer/2016/07/yes-you-can-catch-pokemon-at- auschwitz.html

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design and engineering backgrounds. Firstly in the paper, we clarify the scope of our work (Section 2) by defining MR Games, discussing examples, and identifying a number of papers that do identify ethical problems. We then perform a synthesis of these papers (Section 3) and identify a number of ethical concerns arranged into a set of ethical dimensions for MR. We then follow a normative ethics approach and present a qualitative analysis of 17 interviews we conducted with mixed reality game designers and academics (Section 4), using deductive thematic analysis to extract a set of broad strategies and associated tactics that they use within their own work. Finally, we perform a mapping of strategies to dimensions in order to explore how well our existing toolbox of techniques fits the challenges we face ahead, and we compare them with professional codes of practice from the ACM and IEEE, reflecting on whether this existing practice is adequate (Section 5). Our hope is that our characterisation of the problem, analysis of existing solutions, and discussion of their completeness and fitness for purpose might form part of the basis of future ethical design frameworks.

2 Background

2.1 Mixed Reality

The terminology around Mixed Reality can be confusing. As it was first conceived in the 1990s *Mixed Reality* (MR) was defined using a virtuality continuum that positioned experiences between the real world and entirely virtual worlds (as might be experienced in Virtual Reality) [62]. In this view Mixed Reality contains both *Augmented Reality* (AR) where the real world is extended with digital aspects (such as overlaid graphics), as well as *Augmented Virtuality* (AV) where virtual worlds are extended with real world elements (such as live video feeds).

More recent conceptualisations of MR describe it as sitting between AR and VR, with the distinction that AR is digital information overlaid on the world, whereas MR includes digital information that is aware of and interacts with the real world, with the term eXtended Reality (XR) used to cover all AR, MR, or VR experiences [87].

Other terms associated with MR include *Hybrid Reality*, a term used to refer to systems that bring together elements from the real and virtual worlds [30].[3] *Blended Reality*, which tends to focus on interactions between people across the real and virtual divide (such as a meeting where some people attend in person, and others via video conference) [11] or is used qualitatively to explain cases where real and virtual elements are successfully meshed together to create a new unified type of experience [5]. *Pervasive Games* is a term used by the pervasive systems community, where there is more of a focus on the technological infrastructure rather than the experience created in the user [92]. Finally, *Locative Media* is a term used in an orthogonal sense to includes any digital system that include location data as an important part (for example, social media posts) [7].

Figure 1 shows an updated virtuality continuum that is our attempt to explain how these terms relate to one another in modern usage.[4] In our work on ethics we are interested in any system that alters real world spaces with digital information or interactions, this would include both AR and MR systems in this updated continuum. Ironically – given the plethora of names – there is not a name for this combination, so throughout the paper we use the term Mixed Reality for simplicity and as a reflection of the popularity of that term.

In our scope Mixed Reality Games are therefore games where the real world has primacy, and which use various sensors (such as GPS, Cameras, LiDAR, NFC, etc.) to understand the state of the world (which might be as simple as the user's position within it), *and/or* various media (overlaid graphics, spatial audio, handheld media, haptics, etc.) to bring digital information into that world.

[3]It has been argued that technology is only one lens through which these experiences might be called hybrid, and the distinction is really between conceptual metaphors or cognitive domains [3].

[4]Note: Blended Reality, Pervasive Games, and Locative Media are not shown as they do not describe a particular scope in the virtuality dimension.

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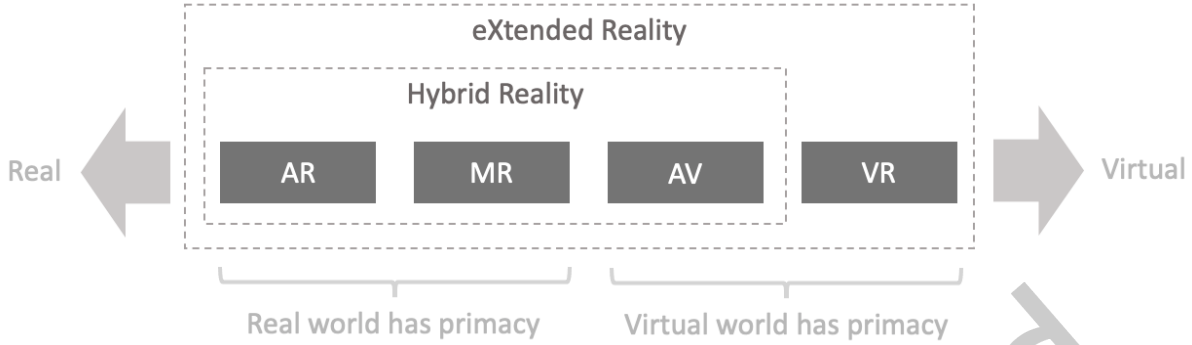

Fig. 1. Updated Virtuality Continuum

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2.2 Mixed Reality Games

Mixed Reality Games have been applied in a wide variety of domains. Early examples, such as the Chawton House project, explored how they might be used within learning activities for children, in this case guiding them between pedagogical activities in the grounds of an 18th century manor house [93]. Avouris and Yiannoutsou provide a good overview of MR Games for learning and how ludic interactions have been linked to pedagogical goals [4]. More recently, perhaps reflecting the increasing maturity and availability of the technology, researchers have turned the tables and worked with students to design locative games as a learning activity in itself [82].

In the heritage domain researchers have also worked with children with the aim of making heritage more accessible, such as the use of interactive locative narratives to help children explore the ancient Roman city of Egnatia [89]. A common strategy is to use AR to superimpose historic media from existing archives on heritage sites to expose unseen heritage layers to visitors [96]. Other motivations include fixing the empty room problem [29], promoting exploration and knowledge [76], or accessing and emphasising the *genius loci* of special sites [9].

Many of these projects have a specific focus on tourism, for example, ExCORA a game to encourage tourists to visit the Urgull Mountain in Spain [51], engage with the area via hunting for QR codes to unlock clues, explore points of interest (POIs), and learn more about the location's hidden history. Similar approaches have also been taken in urban settings, guiding users between POIs and reacting to their current location [68], and cultural differences have been noted in MR Game players between different sites in different areas of the world [44].

There are several different ways in which MR players are conceptualised. Sometimes they are framed as *psycho-geographers*, modern inheritors of the Situationist International [58]. In this view MR Games do not need to be associated with heritage places, or places with any special character at all, instead they use their digital tools to manufacture interesting situations from otherwise banal spaces – this is an approach common to commercial games, such as *Pokemon Go!* where players can collaboratively hunt Pokemon whatever their location, or *CluedUpp* where urban spaces are transformed into play spaces during special paid-access events. An alternative conceptualisation is that MR Gamers are engaged with *rhabdomancy*, the magical art of divining, using digital tools in place of rods, in search of hidden information rather than water [55]; and yet another view is that they are the modern *Flâneur* "walking and surveying the city" to pass the time [19]. Whatever the conceptualisation MR Gamers are special from an ethical point of view because they are engaged in the places around them differently to other occupants of that space, subject to alternative rules, and privy to secret shared knowledge.

2.3 Mixed Reality Ethics

The importance of ethics in augmented and mixed reality has been reported by many. The IEEE Initiative on Ethically Informed Design broadly speaking looks at embedding Aristole's notion of *eudemonia* (human flourishing) in the design of digital systems, including a committee to focus on MR applications [78]. Billinghurst (2021) included research in social and ethical issues as one of his Grand Challenges for Augmented Reality [8], speculating on the impact MR might have on people and their social relationships, and raising questions such as who is allowed to place content in the view of a person, and what are the consequences of people having alternative views of the same environment.

Others have pointed out that the acceptance of MR technologies depends on their appropriate use; unethical or objectionable applications that damage the reputation of MR could lead to overenthusiastic limitations [37]. For example, when Google Glass was introduced with significant media coverage some people reacted by banning users from their spaces, or even threatening violence against the 'Cyborgs' [48]. This pushback was driven by perceived clandestine use of recording technology, as well as the othering of people whose sensory experience is not shared with us.

Old problems are also reinvented by MR. The complex data collected by MR systems and the routine cloud-based processing of that data means that concerns about online privacy are magnified in MR environments, where geotracking can be used to infer a host of valuable Private Personal Information (PPI) items, such as: where you work, the type of work, your income, leisure choices, etc. [47]. But there are also positives. AR and MR represents an opportunity for museums and other cultural organisations to make their collections more accessible, and thus make their offering more inclusive [79]. This represents an ethical imperative rather than a problem.

Many ethical approaches fall into the category of *consequentialism*, the view that the ethical value of a given act should be judged on its outcome. In contrast professional codes of ethics, such as those provided by the ACM [1] and IEEE [32], tend to draw on *deontology* or *virtue* ethics. The first being the idea that it is behaviours rather than outcomes that define ethical actions, and the second focusing on the character and values of the actor rather than actions.

Perhaps because of this difference in ethical approach, and despite this commentary and exploratory work, there is still no comprehensive set of design principles for ethical MR. However, some researchers have done more than highlight specific issues, and have instead attempted to collect a range of potential concerns and begun to create frameworks that describe them. In the next section we will explore some of these frameworks and synthesise their findings in order to better define the problem space of ethical MR Games.

3 Defining the Problem: An Analysis of Existing Frameworks

One of the first attempts to systematically analyse ethical issues in MR was undertaken by Pace (2012) who looked at AR as a persuasive technology [72]. Persuasive technologies are those that have an effect on user behaviour, in the case of AR by encouraging a different type of relationship with physical place. Pace argues that the ethical concerns of the persuasive systems community thus apply, such as control, surveillance, and safety.

Our own preliminary work identified two important ethical dimensions for MR [65]. The first, *responsibility to the person*, includes some of the persuasive computing concerns mentioned by Pace; but the second, *responsibility to place*, is more unique to MR. Perhaps better explained as a responsibility to the people associated with the place, this includes issues such as trespassing, graffiti, and the need to respect cultural norms.

Around the same time Neely also writes about these MR specific issues [67], pointing out the complexity of public vs. private spaces, and how this shapes our perceptions of what is acceptable (for example, contrasting public speech vs graffiti).

In the last three years there have been an number of additional publications that have set out alternative frameworks. Carter and Egliston (2020) attempt to survey issues from the literature [15]. Hyrynsalmi et al. (2021)

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adopt ethical analyses approaches from other fields such as Blockchain [39], and Brun et al. (2023) focus om MR in the context of work, framing their ethical concerns more as traditional health and safety challenges [13]. Royakkers et al. (2021) goes beyond concerns and sets out ethical design guidelines ('The Ten Commandments for Responsible Augmented Reality') [75]. Ramirez (2021) presents a similar ethical guide, focusing particularly on VR, and drawing particular attention to the framing of VR/AR as empathy machines [73].

Table 1 shows a synthesis of all of the concerns identified in the 8 frameworks named above. In total there are 5 dimensions covered by the frameworks, covering 26 different ethical concerns. The dimensions are:

(1) **Claim Rights** - focused on the people associated with the place where the MR Game is situated
(2) **Duty of Care** - focused on the player of the MR Game
(3) **Social Justice** - focused on the social and cultural responsibilities of the designer
(4) **Privacy** - focused on the use of personal data
(5) **Control** - focused on respecting players freedom and agency

In the following subsections we will go through each of these dimensions in turn.

3.1 Claim Rights

Claim rights are issues concerned with the place where the MR is situated and the people who are already invested in that place. This is what we have previously referred to as 'responsibility to place' [65], and Neely groups these under private spaces and uses the lens of property rights to consider the problems [67]. However, stakeholders in this sense are not just those with legal ownership or responsibility but also those with informal stakes. Some may also be contentious or conflicting claims (such as those of indigenous peoples, or alternative religious groups), and we might also extend claim rights to non-humans [86]. The following should thus be interpreted broadly, rather than merely from the perspective of property.

MR Games may or may not directly call for players to **Trespass**, but regardless they can change people's perceptions of space (à la *psychogeography*) and that includes subverting player's perceptions of boundaries between private and public spaces. **Graffiti** describes elements of the game (images, comments, etc) that are left by designers or players within the space to be discovered by others. Graffiti might include slanderous or offensive messages, but regardless of content it conveys a lack of respect for property stakeholders, and may have negative aesthetic consequences. There are also aesthetic issues around the use of certain location technologies, for example QR codes or other visual markers, which leave a physical trace within a place which is experienced by all people regardless of whether they are engaged with the game [90].

MR Games have a more indirect power to affect the way in which we think about places, in particular by emphasising particular **Stories**, or reinforcing the use of certain **Names**. Chess (2013) points out the ability of MR Games to transpose regional and global narratives in order to alter gamer's perceptions of place [18], something that Firmino and Duarte (2010) had already warned could promote a neo-liberal worldview [31]. In contested places (such as indigenous sites, or politically sensitive regions) this ability to privilege certain names and stories is both an opportunity for critical play, and a potential risk of unknowing insult [56].

Finally, there are are **Cultural Norms** associated with places that dictate appropriate behaviour. For example, in their work on designing for deathscapes Häkkilä et al (2018) deploy systems at cemeteries, noting "the importance of unobtrusiveness and respect for the peace and privacy of other visitors" [40]. Playing Pokemon Go! at sacred sites is a good example of where this goes wrong, but when done correctly MR Games can also reinforce appropriate behaviour, for example focusing the attention of children at an archaeological site [89]. More specifically we can also ask whether an MR Game fits the **Intended Use** of a space, or promotes the **Intended Navigation**. Consider the careful way in which Othman et al. (2021) align both the activities and the routes in their game set within the Sarawak Cultural Village with the existing topology of the ethnic houses and their setting around a lake [70]. In our own work on MR Narrative Design we have noted the need for Harmony

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Table 1. Ethical issues identified in the eight ethical framework papers

Dimension	Ethical Concern	# Occ	Pase, 2012 [72]	Millard at al. 2019 [65]	Neely, 2019 [67]	Carter and Egliston, 2020 [15]	Hyrynsalmi et al, 2021 [39]	Royakkers et al. 2021 [75]	Ramirez, 2022 [73]	Brun et al. 2023 [13]
			8	9	4	10	8	10	7	5
Claim Rights	TRESPASS	2		x	x					
	CULTURAL NORMS	5		x	x	x	x	x		
	GRAFFITTI	4		x	x	x		x		
	NAMES	1		x						
	STORIES	1		x						
	INTENDED USE	2			x			x		
	INTENDED NAVIGATION	2				x	x			
Duty of Care	SAFE PASSAGE	6	x	x		x	x	x		x
	ACCURACY	1		x						
	SOCIAL/PYCH NORMS	3	x	x					x	
	WIDE CONSENT	1		x						
	DEVICE ERGONOMICS	2							x	x
	SELF-IMAGE	2						x	x	
	UNWANTED PROJECTION	3				x		x	x	
	CHEATING	1					x			
Social Justice	PHYSICAL ACCESS	2				x				x
	SOCIAL ACCESS	2					x	x		
	INCLUSIVITY	1				x				
	HARASSMENT	1				x				
	EXPLOITATION	1	x							
Privacy	SURVEILLANCE	3	x			x				x
	PERSONAL DATA	4	x				x	x	x	
	INVASION OF PRIVACY	2	x			x				
Control	AUTONOMY	4	x					x	x	x
	DARK PATTERNS / MANIPULATION	4	x				x	x	x	
	USER-LED MANIPULATION	1					x			

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between real world and logical navigation in order to reduce friction for players [64], but it is also an ethical concern as that friction could impact non-players.

3.2 Duty of Care

Duty of Care is the obligation that a designer has to the players of their game, and to others interacting with those players in the same physical or virtual space. We have previously called this 'responsibility to the person' [65]. The term Duty of Care has specific meanings in tort law (and differs across nations and jurisdictions). Here we use it as a broad term that goes beyond any specific legal obligation.

The primary concern must be to ensure that players have **Safe Passage**, meaning that the risks of physical harm during play are minimised. Whilst many would assume that the primary risk comes from encouraging players to enter dangerous places where they would not normally go, Colley et al (2017) point out that is the *movement* between places that is typically problematic, especially regarding pedestrian players and vehicular traffic [22]. MR Games also use physical equipment such as wearables and head mounted displays that can cause fatigue or even injury if used for long periods. **Device Ergonomics** is therefore an important additional safety concern.

Designers also have an obligation to ensure that information they present to their players has good **Accuracy** and is not intentionally or unintentionally misleading. Certain inaccuracies (such as misleading routing) can have an immediate and obvious detrimental effect for players in terms of time and energy wasted, but even mistakes in cultural or historic information can damage the levels of trust that players have in an MR System [91]. Similarly, and especially true in competitive games, players must feel assured that there is no **Cheating** allowed, and that their engagement with an MR Game is fair.

In considering Claim Rights we observed that designers need to respect cultural norms, now when looking at Duty of Care we can see that the other side of that manifests in respecting **Social/Psychological Norms** (i.e. not embarrassing or otherwise making players feel discomfort), and also in seeking **Wide Consent** - not just from the players, but from non-players in the same space. MR Games are different from other activities that might take place in the physical realm in that they bypass our normal expectations and methods for managing wide consent (such as seeking permission, warning people in advance, or negotiating a financial contribution towards that space), the issues they raise are thus not new, but the old mechanisms for dealing with them may no longer work [81].

Ramirez (2018) points out that in extreme cases discomfort can become trauma, and suggests applying *The Equivalence Principle* - that if it would be wrong to subject a person to an experience then it would also be wrong to subject them to a virtual equivalent [74].

MR Games also allow their users to play with identity, both their own **Self Image** (the manipulation of which might have harmful consequences, such as the influence of Instagram filters on young women [38]), as well as enabling **Unwanted Projection** on others. As Wolf (2016) argues: "the possibility of decorating others, especially without their consent, seems fraught with difficulties and potential abuse." [95]

3.3 Social Justice

Social Justice concerns are not unique to MR Games, but rather reflect the wider aspects of technology use and how it might discriminate against or unequally empower different members of society.

Physical Access refers to both availability of technological devices and also the ability to access physical locations. While access to location services is much more ubiquitous in smart phones today than it was even a decade ago [54], there are still significant minorities that do not have access to smart devices at all. Digital accessibility also inherits problems from the physical world when digital materials are linked with physical places, where practical barriers may exclude certain participants (such as including areas in an MR Game that are non-wheelchair accessible).

Social Access and **Inclusivity** are also about audience exclusion. Social Access refer to any restrictions on audience (even if indirect, such as targeting particular neighbourhoods) and relates to physical access in cases

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where that is related to social factors (such as the affordability of devices or software). Inclusivity refers to restrictions around those depicted in the MR Games themselves, does the experience contain or reference people and cultures with whom users could identify? This can be an important factor in modern tourism, where people may visit places based on their perceived social and cultural associations with that place, what Bond and Falk (2013) call *Affinity Seekers* [10]. In both cases there may be issues with discrimination between different groups, or the marginalisation of certain groups – which might be through something as simple as language diversity, which we know can be a challenge in digital systems [83].

The opposite of Inclusivity is **Exploitation**, where particular groups are included, but are targeted in a negative way. Online exploitation is often seen in relation to children and the dangers of grooming [6], MR Exploitation may be more pervasive as systems leverage the trust that users feel in their smart devices and personal technology (it is thus linked to the dimension of *Control* described below).

Harassment is also a problem imported from the online space. Online harassment has a different character to traditional forms of bullying, and often takes the form of one-off negative interactions with strangers [94]. This might be motivated by trolling (a form of sadistic thrill seeking [23]) or have a cultural basis (such as misogynistic movements [42]). MR has the potential to provide new tools to bad actors, especially if the system is open to public contributions. In their framework Carter and Egliston emphasise sexual harassment as a particular challenge for MR Games but also acknowledge the potential for verbal or physical harassment [15].

3.4 Privacy

People interacting with MR Games not only bring digital data about themselves into the physical world, but they are also generating significantly more data through their MR interactions, Kotsios (2015) frames this as three types of MR private information: of the person, of behaviour/actions, and of location and space [48].

In the literature concerns over this dimension falls into three categories. The first is **Surveillance**, and is concerned with the extra data that is generated through MR interactions. Santaella posits that locative media creates the opportunity for a new kind of *tracking surveillance* that (unlike scopic or panoptic surveillance) is directly engaged with the person [77], and Michael and Clarke (2012) argue that this unification of digital and physical data means that locative systems like MR Games actually become a form of überveillence [60] that is an 'all encompassing, all-pervading view of the citizen'. MR technologies might also shift data gathering from surveillance to *sousveillance*, a bottom up view that draws on the data traces that people form of each other rather than those formed by some external authority (think camera phones vs. CCTV) [37].

Surveillance/Sousveillance is about the act of gathering data, but once it is gathered we might also be concerned about how **Personal Data** is managed. Studies have shown that, just as with online activities, players of MR Games are not overly concerned by how their data is being used [35], but we also know that individual's privacy calculus is imperfect, as the information transfer is asymmetric, and that players might be divulging more about themselves than they realise [49].

Finally, MR Games could potentially include functionality that constitutes an **Invasion of Privacy**. This is where private information that would not otherwise be apparent is disclosed to others. This can be innocent and consentful, such as the biometrics transmitted by the MR Game *HeartBeat*, but on other occasions it raises questions about whether the one sensing the data has the right to use or broadcast it (for example, in disease detection [80]).

3.5 Control

Control in MR Games can manifest through direct **Manipulation**, for example the use of *Dark Patterns* to encourage users to behave in particular ways [33], this is exacerbated by the fact that many MR Games are played on personal (and therefore trusted) devices [61]. The manipulation could also be well intentioned, for example in

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order to help the user experience the world from a minority viewpoint. Although, Ramirez (2021) argues that this use of MR as an 'empathy machine' is also unethical [73] as it does not take account of semantic variance (that meaning depends on context and that the context of each user is different and thus their interpretation will be different) and is therefore a sort of emotional manipulation that can never really deliver on its promise of authenticity.

MR Games that open parts of their design to users can also open them to **User-led Manipulation**, where bad actors can attempt to influence other players. We see equivalences to this in the online space with Fake News or Review Bombing [88]. This could be in terms of allowing for user content, such as the locative game *Free All Monsters* that allows users to upload their own monster designs into a 'Liber Monstrorum' (hosted on Flickr) making a game that is part of a larger creative experience [25], or it can be an explicit design-in-play strategy where locations and rules can be configured by one group of players to be experienced by another [34].

A related problem is that MR Games restrict **Autonomy** – a person's 'freedom to make independent decisions' [75] either directly by restricting choices, or indirectly by making users more self-conscious of their actions. In work-related MR applications this restricted cognitive autonomy can affect satisfaction and work commitment [41], in MR Games it creates new 'information territories', areas of control and surveillance that can influence how players behave [28].

4 Exploring Solutions: Existing Ethical Strategies

Having identified the ethical issues described in the literature we now move on to consider what strategies researchers and developers are using to manage them. This is rarely the focus of research publications, so rather than the literature we turned to the researchers and developers themselves through a series of qualitative interviews.

4.1 Methodology

To construct our sample we contacted the lead authors of papers in the literature, and then followed a snowball approach, and conducted semi-structured interviews either with those people directly, or with colleagues that they recommended (the study was conducted under University of Southampton Ethics approval, ID: ERGO/FEPS/49406). The interviews were conducted over phone or video conference, and the audio was recorded for later analysis. As such the interviewees represent an opportunistic sample (based on authors preparedness to take part). In total 17 participants agreed to do so.

The interviews were semi-structured and were based around the ethical concerns specific to MR Games (Claim Rights and Duty of Care) identified in the first phase of the research. Following an ice-breaker question the interviewees were asked whether they had experienced any of the ethical issues, and in every case asked whether they did anything in their design process to mitigate potential problems. At the end of the interview they were also given the opportunity to add their own observations and comments about their ethical practice.

The interviews were conducted by two separate members of the project team, and then a reflexive thematic analysis of those recordings was undertaken following Braun and Clarke's approach [43]. A third member of the team undertook the initial familiarisation and coding, with timestamp software used to code responses that represented specific *tactics* that the interviewees had described. This codebook evolved throughout the analysis of all 17 interviews, and the codes were refactored and redefined iteratively throughout the process. Following the development of this codebook the team came together to generate an initial set of themes representing groups of similar codes that together could be said to represent particular *strategies*. Over a series of meetings these themes were developed and reviewed.

In many cases our work could be descriptive as our subjects were often researchers themselves with a clear vocabulary (for example, 'Living Consent' which came from a participant with a long history of working with

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indigenous peoples). However, in some cases we took a more interpretive approach, looking for more abstract ideas that would link specific actions (for example, 'Normalcy' which was expressed in very different ways by participants depending on the context and type of MR Game being discussed). In our interpretations we drew on our own experiences as MR Game designers and researchers, referring back to the original recordings to ensure that we didn't impose our own approaches onto the work of others. The writing stage was a critical final part to this iterative approach, in particular for refining descriptions. This interview and analysis work occurred between 2019 and 2022.

4.2 Results

We identified 13 strategies used by our interviewees, consisting of 59 distinct tactics. These strategies were split between the areas of Design, Participant Management, and Logistics, and are explained in the following three sections. (Note, that quotes are attributed to participants P1-P17, and are anonymised versions of what was actually said.)

4.2.1 Design Strategies. Table 2 shows the 5 Design Strategies and 31 Tactics described by our interviewees. In each case we have shown the total number of unique mentions and used this to order the rows.[5]

Design strategies are those that apply during the conception and development of a mixed reality game. The most popular approach was **Inclusive Design** where designers attempt to incorporate the views and perspectives of stakeholders (including participants) into their experience. This could be indirectly through independent *research*, or by directly involving them (for example, as part of a *review*, or a full *participatory design* process). Difficult material might be *integrated* into the experience, avoided by taking a position of *neutrality*, or *stylised content* used to soften its impact.

> "our story was that a hero took his men to a camp and killed everyone, and there were concerns about the blood, but we met them in the middle by using a comic style and they felt that was okay." [P10]

In almost all cases designers aimed for **Stakeholder Participation** of some form, at the very least to establish some form of *cooperation* to ensure they had permission to use a given space, but also to get access to *curated content*. One interviewee had worked with indigenous peoples where the western view of legal and defined consent was not appropriate, in this case they instead sort *living consent*, the permission of an elder which was part of an ongoing relationship between the indigenous people and the researchers.

An **Editorial Process** was also common, where *locations*, *content*, or *behaviour* was reviewed within the team to ensure that the experience was appropriate in their view. Although the rules for editors were not necessarily set out formally, one interviewee explicitly mentioned that the *aesthetics* of the experience was key, and that all the stakeholders deserved objects that were beautiful and pleasing. *Authorial advice* given to content creators was used to streamline this process.

> "They are created as objects of Art, but are augmented reality codes, and when scanned they unfold and enlarge… they are quite beautiful." [P6]

A number of design tactics were focused on ensuring that the experience was properly **Integrated** with the place. This could be achieved by making sure participants did not stand out by designing behaviour that matched *normalcy* for that location (in effect a type of *behavioural exclusion*, or by ensuring that the experience *mimicked* a particular type of real-life behaviour). An alternative approach was to lose participants in the space, either by *diffusing* a small experience into a large area or by *choosing a moment* where any unusual behaviour would be masked by real-life events (thus enabling *normalcy*, or in the case of exceptionally quiet moments, *diffusion*). At worst the experience could be made *temporary* to minimise its impact. In all cases designers could use *hidden*

[5]So for example, RESEARCH was mentioned by 6 unique participants, and Inclusive Design had 21 unique participant/tactic pairs.

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devices to disguise participants, or choose *passive technology* that did not require the physical locations to be altered.

> ”One place was under the control of a local archaeological unit, and we wanted to place QR codes in that area but were not allowed to… we just chose to switch technology and use GPS” [P1]

Finally, **Interactions** can be designed around the needs of participants. These considerations might be built into the experience, such as *pausing* navigation during other types of interaction, or it could be placed in the users control, allowing them to miss *optional content* or *stop* the experience early. Providing clear guidance through the experience was also mentioned, using *recognisable names* to help participants orientate themselves, or carefully *directing attention* through other means. An alternative is to be deliberately *vague* setting the participant's expectations according to the nature of the experience and at an appropriate level for what the technology can actually deliver.

> “More recent versions [of our app] use embedded photos or clues or hints rather than explicit instructions… the game is about exploration and discovery and that expectation is set up at the beginning of the experience.” [P4]

Two interviewees described how they *emulated* the experience digitally to give participants alternative ways of taking part.

> “people can go back to their hotel and explore the park in couch mode exploring the experience there.”[P3]

Interactions could also be used to create a safe space for the experience, physically *separating* it from other activities at the location, or using cues to clearly *distinguish* participants from other visitors. Communication between participants was not frequently mentioned by our interviewees, but in a similar spirit of creating a protected experience, it was suggested that when communication was implemented it should be *non-verbal* to keep that communication within limits set out by the design.

4.2.2 Participant Management Strategies. Table 3 shows the 5 Participant Management Strategies and 19 Tactics described by our interviewees. Participant Management Strategies typically apply during the planning and deployment of a mixed reality experience, and after the experience has completed.

The most popular approach was **Participant Control** which is about selecting who takes part in the experience, for example, during deployment bystanders might be actively *excluded*. Providing *trigger warnings* allows participants to exclude themselves if they are unsure, alternatively a *filtering* process can be used by the team to explicitly select a certain type of participant, in particular an *adults only* policy would exclude minors (or they might be included with explicit *parental consent*).

Participants can be prepared for the experience through **Training**, it was relatively common to hold a *briefing* for participants, or even run an entire *initiation phase* as a preliminary part of the experience. At the very least they can be provided with a *rubric* that gives them essential information on what they are about to do.

> “Being able to explain to them the scale and the nature of the space they were going around in... we gave them a little map with a vague outline of the area... it meant that the reader was making a much a more informed decision. ” [P13]

Many interviewees believed that **Framing** the experience was important to set expectations and create a *magic circle* with its own behavioural norms. This might involve presenting the experience in a *cultural context*, or drawing on the legitimacy of a formal research *study*. In all cases it might be important to *reassure* participants about the designers motives, and be clear that they are valued and respected by the developers.

> “My perspective comes from documentary performance studies, so I would refer to the environment and space in which people are creating as either an actualisation or a magic circle.” [P12]

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Strategies	#	Tactics	#	Description
Inclusive Design	21	RESEARCH	6	Team researches the location to uncover any sensitivities
		EXTERNAL REVIEW	6	Review content with stakeholders or independent experts)
		PARTICIPATORY DESIGN	3	Involve participants in the design of the experience
		INTEGRATION	3	Directly addressing challenging topics with story or game play
		NEUTRALITY	2	Taking a neutral stance to remain inclusive and avoid offence
		STYLISED CONTENT	1	Using stylised content (e.g. comic art) for unpalatable content
Stakeholder Participation	20	COOPERATION	11	Co-operate with local stakeholders for permission/support
		CURATED CONTENT	8	Involve local stakeholders in the creation of the content
		LIVING CONSENT	1	Consent established through ongoing relationships
Editorial Process	17	EXCLUDING LOCATIONS	6	Editorial process to remove problematic locations
		EXCLUDING CONTENT	5	Editorial process to remove problematic content
		EXCLUDING BEHAVIOUR	4	Editorial process to remove problematic behaviour
		AESTHETIC	1	Ensuring deployed objects are beautiful and pleasing
		AUTHORIAL ADVICE	1	Providing advice to authors on best practice
Interaction Design	13	PAUSING	2	Halt navigation to allow part of the experience to happen safely
		OPTIONAL CONTENT	2	Aspects of the experience are optional and people can choose
		EMULATION	2	Emulate the experience in VR rather than use a real location
		SEPERATION	1	Separate the MR experience from the usual visiting experience
		STOPPING	1	Designing opt-outs or stopping points into the experience
		RECOGNISABLE NAMES	1	Use recognisable names to minimise confusion
		DIRECTING ATTENTION	1	Visual/audio cues to direct attention to important information
		VAGUERY	1	Using vague information to reduce expectations of accuracy
		NON-VERBAL	1	Indirect communivation (e.g. gestures rather than words)
		DIFFERENTIATION	1	Clearly distinguishing participants from other visitors
Integration Design	11	NORMALCY	3	Respecting the bounds of normal behaviour for a site
		DIFFUSION	2	Large areas / low visitor numbers that reduce interactions
		CHOOSE YOUR MOMENT	2	Aligning deployment with other unusual events (e.g. festival)
		PASSIVE TECHNOLOGY	1	Avoiding installation of technology (e.g. GPS over QR codes)
		TEMPORARY	1	Temporary deployment, easily installed and removed
		MIMICKING	1	Copy existing activities that already occur in the space
		HIDDEN DEVICES	1	Hiding the device so than participants do not stand out

Table 2. Design Strategies Identified in the Interviews (5 strategies, 31 tactics, 82 total unique mentions)

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Some of the Interviewees thought that **Reflection** was an important stage of an ethical experience, either with *reflective gaps* during the experience itself, of post-experience through a *debrief* or even an ongoing *support group*.

> "As they are walking to these sites I am also reflecting [through narration] on my relationship to place and inviting the player or the user of the app to reflect in their way" [P9]

Finally, **Personal Data** was occasionally mentioned as an important consideration. This could be through *limiting logging* of data to only what was necessary, through allowing participants to *review* the data that had been collected on them, and/or to request its *deletion* if they so wished. Keeping participants *informed* of any results or developments was seen as a way of maintaining consent and making these options meaningful.

4.2.3 Logistical Strategies. Table 4 shows the 3 Logistical Strategies and 9 Tactics described by our interviewees. Logistical Strategies typically apply to managing the live experience.

Live Monitoring of the experience was the most frequently mentioned logistical strategy. *Monitoring* was mostly discussed in general terms, but more specifically it was described as a way giving *real-time feedback* to warn users of any issues, as a way of spotting issues and alerting a member of the team to provide a *live fix*, or even of flagging the whole or part of the experience for *cancellation*. Most of the methods of live-monitoring were assumed to be digital, but interviewees also described the role being done by the user themselves through *regular warning* messages, or by a member of the project team acting as a *chaperone*.

> "If it's a museum or palace then you have to have someone with you, and you are not allowed to run... treasure hunt games sometimes they [participants] go berserk.. this is not allowed" [P7]

Strategies	#	Tactics	#	Description
Participant Control	9	TRIGGER WARNING	4	Warn participants upfront about potential upsetting content
		ADULTS ONLY	2	Excluding minors from the study
		FILTERING PARTICIPANTS	1	Filter out participants uncomfortable with the experience
		PARENTAL CONSENT	1	Seeking explicit parental consent if participants are minors
		EXCLUDING BYSTANDERS	1	Remove (or exclude) non-participants from the relevant area
Training	8	BRIEFING	5	Demonstrate the system and set expectations
		INITIATION PHASE	2	To orientate users and get them used to the technology
		RUBRIC	1	Up front information on the experience (e.g. size/duration)
Framing	7	MAGIC CIRCLE	3	Framing as a play or art to create a 'magic circle' effect
		CULTURAL CONTEXT	2	Framing within an existing cultural/educational initiative
		REASSURANCE	1	Reassurance about motive (e.g. its not to test users))
		STUDY	1	Framing within a research study (and its ethical framework)
Reflection	4	REFLECTIVE GAPS	2	Designing time to reflect on challenging content
		SUPPORT GROUP	1	To communicate issues and to reflect on their experience
		DEBRIEF	1	Post-experience discussion to help reflect on the experience
Personal Data Management	4	POST FEEDBACK	1	Allow users to request to be informed of any results
		DATA REVIEW	1	Allow review of collected data (and request its removal)
		USER DELETION	1	Allowing users to remove their own content
		LIMIT LOGGING	1	Log only essential aspects (e.g. logging events not locations)

Table 3. Participant Management Strategies Identified in the Interviews (5 strategies, 19 tactics, 32 total unique mentions)

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Perhaps reflecting our interviewees' role as developers they also saw **Playtesting** as an ethical strategy, and a way of ensuring a quality experience to people who had volunteered their time as participants. This could be in the form of *experimentation*, trialling different ideas, as well as *piloting* a more advanced design to test all aspects of the experience.

Finally, several interviewees mentioned the importance of **Pre-visit** setup, describing how *prior arrangements* had to be made before the experience to ensure that it would work smoothly, these comments were often made retrospectively having encountered a problem.

> "unfortunately the building where the object was located was locked, this was a failure on our part… we expected that the building would be open that day." [P1]

5 Discussion

Our initial review of the eight papers looking at ethical concerns reveals a complex ethical landscape with genuine ethical conundrums – such as the tension between the Claim Rights of local stakeholders with the Liberty Rights

Strategies	#	Tactics	#	Description
Live Monitoring	15	MONITORING	6	Live monitoring so the team can intervene if needed
		CANCELLATION	3	Remove elements in the light of complaints / changes
		REAL TIME FEEDBACK	2	Look for emergent problems and warn users or halt completely
		CHAPERONE	2	Have someone accompany participants to check behaviour
		LIVE FIX	1	Correcting content during the live experience
		REGULAR WARNINGS	1	Pop up warnings to behave responsibly / avoid danger
Playtesting	5	PILOTING	4	Test the experience to see if it functions as designed
		EXPERIMENTATION	1	Trying different things at different locations to spot issues
Pre-Visit	5	PRIOR ARRANGEMENT	4	Arrangements made before the experience to enable it to work

Table 4. Logistical Strategies Identified in the Interviews (3 strategies, 9 tactics, 25 total unique mentions)

of the public. Where this balance falls is likely to be a result of local cultural and political factors, implying that for MR Games one size of ethical rules will not fit all. The focus of our work on the academic sphere (both in terms of identifying risks, and exploring solutions) also downplays the economic aspects of MR Games, and the tensions that exist between sustainable monetisation and ethical imperatives such as privacy (for example, in the context of surveillance capitalism [98]).

On the positive side the analysis of strategies shows a wide ranging set of methods that are already being deployed to ensure ethical experiences. Many seem adapted from research ethics (for example, inclusive design, stakeholder participation, participant control, personal data management, and live monitoring), and many of our participants thought primary about ethics in these terms, needing some prompting to go beyond research ethics to the experience itself. Others, particularly those dealing with contested spaces, recognised immediately that there were specific ethical questions that they had needed to deal with.

In the following sections we will explore how our dimensions and strategies map to one another, how they relate to existing professional codes of ethics in computing and digital technology, and finally discuss what sort of ethical approach might be needed in the future to create frameworks or policies for the ethical development of MR Games.

5.1 Strategies vs. Ethical Dimensions

Table 5 shows a mapping of the strategies that we identified from our interviews (Section 4) to the ethical dimensions we identified in our review of existing literature (Section 3). This mapping is based on the actual tactics reported within each strategy (rather than activities about which we might speculate).

There are strategies available in all of the ethical dimensions, although some are better covered than others. The gaps highlight potential areas where new strategies might be developed. For example, Claim Rights and Social Justice are well represented in the area of Design, but not Participation Management or Logistical Areas, which implies that stakeholders might need to be more actively involved in deployments and monitoring, and that there is a lack of feedback methods that would allow researchers to respond to new issues that might arise.

Privacy is the least represented dimension. This is unexpected, as our interviewees were mainly researchers dealing with existing University ethical processes that typically lean towards research data management and

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Table 5. Mapping of Strategies to Ethical Dimensions

		Claim Rights	Duty of Care	Social Justice	Privacy	Control
Design	Inclusive Design	x	x	x		
	Stakeholder Participation	x		x		
	Editorial Process	x	x	x		x
	Interaction Design		x			x
	Integration Design	x	x			
Participant Management	Participant Control		x			
	Training		x			
	Framing		x			
	Reflection		x			x
	Personal Data Management				x	
Logistical	Live Monitoring		x			
	Playtesting		x			
	Pre-visit		x			

privacy concerns. The disjunction between research ethics and situational ethics for field work has been noted before [66], but in this case the issue seems to be the falsely reassuring presence of an existing research ethical framework, rather than any deficiency with those frameworks. This may have led to data management strategies being both invisible because of their ubiquity, reflected in the low number of participants (4) that reported it, and overly relied on to guarantee privacy. There were few Privacy by Design [16, 84] strategies reported in our interviews (one exception being to *Limit Logging*), but this approach is an example of how Privacy might be considered in other areas.

5.2 Existing codes of ethics

Both the ACM and the IEEE offer codes of conduct for computing professionals that are relevant to any ethical framework for MR games. The IEEE code of ethics [1] is a focused set of 10 principles, and the ACM Code of Ethics and Professional Conduct [32] is a somewhat longer document containing 25 principles. Both cover professional obligations and expectations as well as general ethical principles, and in both cases they are expressed in terms of behaviours that members should enact.

In the following discussion we will use the first section of the ACM Code as the framing (using ACM X where X is the number of the article in the code, but will refer to the IEEE code where appropriate (using IEEE X where X is the number of the article in the code). This first section concerns general ethics (rather than professional principles such as the need to foster public understanding of the discipline (ACM 2.7, IEEE 2) or to maintain professional competences (ACM 2.2, IEEE 6)). We can then compare these to our ethical dimensions and strategies in order to demonstrate how they might be realised in MR Games.

ACM 1.1 Contribute to society and to human well-being (acknowledging that all people are stakeholders in computing). This principle calls on computing professionals to undertake work that benefits society. More of a general aim than principle it is actually an umbrella for the next six principles, but crucially calls for broad engagement with stakeholders – something that links to the *Claim Rights* dimension of our ethical concerns, and is thus addressed by strategies such as *Inclusive Design* and *Stakeholder Participation*.

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ACM 1.2 Avoid harm This principle refers to a broad spectrum of harms: both physical and mental injury, as well as damage to property, reputation, or environment. The IEEE breaks this into public welfare (IEEE 1), avoiding harassment (IEEE 8) as well as avoiding injury (IEEE 9). This principle is covered by the dimension *Duty of Care*, which is well served with strategies across Design (e.g. *Inclusive Design*, *Editorial Process*), Participant Management (e.g. *Training*, *Reflection*), and Logistical (e.g. *Live Monitoring*).

ACM 1.3 Be honest and trustworthy This principle calls for transparency, full disclosure, and the avoidance of misleading claims and fabrications. The IEEE has a very similar principle (IEEE 5) that includes most of the same key points. Of our dimensions the principle is most closely linked with *Control*, and especially the aspects of manipulation and subterfuge. This aspect is addressed by strategies such as *Interaction Design* that empowers users, an *Editorial Process* that checks for dishonest claims, and *Reflection* that helps users understand their experiences. It is also related to *Accuracy* from *Duty of Care*, which is also addressed by an appropriate *Editorial Process*.

ACM 1.4 Be fair and take action not to discriminate This principle calls for equality, tolerance, respect for others, and justice. The IEEE has a similar principle dealing with fairness and the avoidance of discrimination (IEEE 7). It is linked to the *Social Justice* dimension, and is can therefore be addressed by strategies such as *Inclusive Design*, *Stakeholder Participation*, and an appropriate *Editorial Process*.

ACM 1.5 Respect the work required to produce (new ideas, inventions, creative works, and computing artifacts). This principle calls on members to credit inventors and creators, and respect copyright and license agreements. The IEEE does not have a similarly focused point, although it is arguably covered by their very general principle to avoid unlawful conduct (IEEE 4). Superficially this principle seems to map to the *Claim Rights* ethical dimension, however as expressed in the MR literature this refers to the claim rights of local stakeholders and land owners, rather than the owners of creative works and intellectual property. It is also worth noting that neither the ACM nor the IEEE go beyond legal protections to talk about the rights of creators to freedom of expression. This suggests that there are deficiencies in the strategies for both enabling free expression within the law, and in our protections of the artefacts that are subsequently created.

ACM 1.6 Respect privacy The IEEE covers this as part of their first principle including it as part of public welfare (IEEE 1). It maps directly to the ethical dimension of *Privacy*, and is therefore addressed by *Personal Data Management* strategies, although as we noted above these all fall in the Participant Management area, and miss integration with design.

ACM 1.7 Honour confidentiality This is similar to ACM 1.6 but refers to organisations rather than individuals, personal data is thus replaced by confidential data such as trade secrets, patent applications, etc. There is no corresponding principle in the IEEE code, although it is another example, assuming there is a contractual agreement in place, that is covered by the principle to avoid unlawful conduct (IEEE 4). Ethical issues of confidentiality were not mentioned in the MR literature and there are no specific strategies associated with it. This suggests that we are missing strategies that formalise expectations between designers, stakeholders, and artists, and that existing projects may rely to heavily on good will.

Both ethical codes provide a fine framework for professionals, but lack concrete methods or processes that would show people how to meet their principles. This is necessity when creating a code for such a broad professional area. In the mappings above we show how these can be translated into MR Games, and provide specific ethical strategies (and thus tactics) in order to meet those higher level ethical standards.

5.3 Deontological vs. Virtue Ethics

As described in Section 2.3 a *deontological ethics* approach refers to the creation of rules or commandments that when followed will result in an ethical outcome, whilst an alternative is to follow a *virtue ethics* approach,

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where we would instead define the qualities that we expect to be paramount in ethical judgements. Concisely: deontological ethics defines ethical actions, virtue ethics define ethical people.

The professional codes of ethics described above tend to mix these approaches, drawing out general deontological rules such as 'Avoid harm' from underlying virtues such as respect or beneficence. However this can be lost when those codes are translated into processes or frameworks such as those followed by many research institutions which emphasise the deontological aspects alone. Researchers are required to follow a strict process, to define a data management strategy, and to use templates for consent forms. If the process is followed the outcomes are assumed to be ethical. One of our participants was very uncomfortable about how this might degrade ethical thinking:

> "We make the illusion that we are protecting people by asking them to sign things... [and yet] we have enough experience that we know what is going to be within the realms of what is considered fair." [P17]

This participant was suspicious of an approach that was designed to protect the institution and make the process easy – rather than actually respecting the rights of individuals and empowering them in the research.

Table 5 shows that the Design area is where most of the strategies sit that deal with multiple ethical dimensions, and it accounts for nearly 60% of all the strategies discussed by participants. But many of these strategies only offer the *opportunity* to address ethical concerns rather than ensuring it (for example, an editorial process will only address Control if autonomy is explicitly considered as part of the editorial process). There is thus still a reliance on the ethical judgement and qualities of the project team.

Our analysis captures a snapshot of what issues are being discussed by theorists, and the strategies that are being used in practice. It is therefore a descriptive rather than a prescriptive account of the ethics of mixed reality games as they stand at this particular moment in time. There is clearly still a distance between these frameworks (even as a collection) and fully engaged ethical practice. There are clear gaps in the mapping that reveal an apparently empty possibility space, there will be specific tactics or even strategies that were not captured by our analysis that might fill these, but they might also require the development of new approaches. Also, at a practical level, the relative importance of these issues is not clear and may be contextual; some of the issues seem key to unlocking others (for example, addressing *wide consent* and consulting with people who are not direct stakeholders or players seems key to understanding the larger picture of *cultural norms*, *stories*, and *intended use*, as well as many of the issues within *social justice*).

Combining the strategies with professional codes of ethics as we have done in Section 5.2 fills in some of these gaps but in mapping principles to specific strategies and tactics we move further towards a systematic deontological approach, which hides the fundamental importance of the underlying virtues embedded in those codes of practice. We would therefore encourage designers to always act reflectively and remain proactively engaged with the ethical process. The strategies and tactics that we have identified here are a tool, but should never be a shield.

6 Conclusions

In this paper we have looked at the emerging ethics of Mixed Reality Games, with the assumption that a technology that has the power to transform people's experience of place will naturally raise unique ethical challenges. Synthesising the work of a number of different researchers we find 26 different ethical concerns that can be collected into 5 different dimensions:

(1) **Claim Rights** - focused on the people associated with the place where the MR Game is situated, e.g. preserving cultural norms, or protecting them from trespass and graffiti.
(2) **Duty of Care** - focused on the player of the MR Game, e.g. their safe passage and consent, and requirements for accuracy and fairness.

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(3) **Social Justice** - focused on the social and cultural responsibilities of the designer, e.g. providing accessible and inclusive experiences, protecting people from harassment or exploitation.
(4) **Privacy** - focused on the use of personal data, e.g. managing surveillance and protecting players information from each other.
(5) **Control** - focused on respecting players freedom and agency, e.g. avoiding dark patterns, preventing player manipulation.

We have conducted interviews with 17 MR Game Designers in order to elicit a set of strategies that they currently employ in order to address these concerns. They described 59 distinct methods (tactics) that fit into 13 strategies across three areas:

(1) **Design Strategies** - that apply during the conception and development of an MR experience: Practising inclusive design, involving stakeholders, developing an editorial process, through careful interaction design, and integrating with existing activities on site.
(2) **Participant Management Strategies** - that apply to the selection and support of players: Controlling who participates, training them adequately, framing the experience in a positive way, providing space for reflection, and giving them power over their personal data.
(3) **Logistical Strategies** - that apply to the management of the live experience: Live monitoring, pretesting, and undertaking pre-visit checks.

We have shown that when mapped together these strategies provide cover for all of the dimensions, however Duty of Care is far better supported that any other dimension, and Design Strategies tend to be the ones that apply most broadly. There appears to be a need to create new strategies for Participant Management and Logistics, in particular in areas outside of Duty of Care, in order to provide more options for designers.

Finally we show how these strategies relate to existing codes of ethics from the ACM and IEEE. Most of the ACM principles of general ethics can be translated into one or more of the MR Game dimensions (for example, the ACM principle of Avoiding Harm is served by our dimension on providing a Duty of Care) which then enables strategies to be identified that would enable an MR Game Designer to meet those obligations (for example, Duty of Care is well served by strategies across Design, Participant Control, and Logistics). One notable gap is support for the rights of creators and the protection of free expression, this was not identified in our dimensions, and would need to be explicitly incorporated into tactics such as an *Editorial Process*. It implies that in the current ethical balance Claim Rights tend to focus on real places rather than digital artefacts, and that they also tend to be considered over Liberty Rights. Another deficiency was around the area of confidentiality, and the formalisation of expectations and relationships between designers, stakeholders, and artists. There is a need to develop strategies that formalise these relationships and set out obligations.

Our work is not only a wide-ranging review of ethical concerns and the strategies currently employed by designers, but also a first step in providing guidance to designers in how to fulfil their professional code of ethics.

6.1 Limitations and Future Work

Any analytical work such as this is naturally limited by the original work that was identified for synthesis, and the participants invited to the study. In the first case there is relatively little work in the area, although it is clearly growing, and thus we cannot claim that our dimensions are fully comprehensive. However, they do represent a range of viewpoints, and are demonstrably useful for understanding how different strategies fit into the ethical space. In the second our snowball sample is opportunistic rather than selected, and covers academics and designers from multiple countries and disciplines, however it leans towards academia and cultural heritage (a strong focus in academia) rather than purely commercial games. This means our set of strategies should be considered as a potential set of approaches, rather than as a representative sample of practice.

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In both cases it is also worth pointing out that while there are literally hundreds of MR Games [63] their audience and impact is still relatively small, and that therefore many of the ethical concerns are speculative. New dimensions will emerge with technological innovations (Large Language Models are a recent example), and use will determine which are the most pressing for society to deal with.

There is also a difference between ethical and legal obligations, although the former should clearly inform the later. A full legal analysis of MR games is beyond the scope of this paper, but existing legislation around liability, civil trespass and anti-social behaviour are clearly relevant. As MR games become more popular and visible there will undoubtedly be pressure for new laws, and it is ultimately in our interests to explore what is acceptable and desired before this happens.

Finally, in our analysis we noted that there is an issue with taking on overly deontological approach to ethics, especially since many of the strategies we have identified still depend on virtues. It is likely that a full framework of ethics will need to emphasise critical engagement with ethical development, and identify a set of complimentary ethical virtues, with strategies as scaffolding rather than as a guaranteed guide.

6.2 Final Remarks

MR Games will become more popular as MR technology becomes smaller, cheaper, and more accessible. The history of technology shows us that at the same time providers will become larger, platforms will be consolidated, and common userbases will grow in line with network effects. Ethical issues that may seem trivial in a short-lived research project will be writ large in such an environment, with MR spaces adopted for national and cultural commentary and debate in much the same way as social media spaces are today. In such an environment governments will need to legislate appropriate behaviour, organisations will need to set codes of conduct, and individuals will need to make decisions about their own actions and engagement.

Our hope is that the work on the ethics of MR Games being undertaken in this paper, and by the authors from whom we draw, will provide both a theoretical foundation for discussing these issues in the future, and the basis for emerging practical ethical frameworks and guides. The goal being that the negative potential of MR games is minimised, while the benefits become available to the widest numbers of people.

Acknowledgments

This work was undertaken with support from the Web Science Institute, and the European Union and UKRI as part of the LoGaCulture project. The authors also wish to thank Kieron O'Hara and our extended colleagues within the LoGaCulture project for their support and feedback on the drafts of this paper.

References

[1] 2020. *IEEE Code of Ethics*. Technical Report. https://www.ieee.org/about/corporate/governance/p7-8.html

[2] Natsuko Akagawa. 2018. Authorized Heritage Discourse. In *The Encyclopedia of Archaeological Sciences*. John Wiley & Sons, Ltd, 1–4. https://doi.org/10.1002/9781119188230.saseas0056

[3] Jonne Arjoranta, Ville Kankainen, and Timo Nummenmaa. 2016. Blending in Hybrid Games: Understanding Hybrid Games Through Experience. In *Proceedings of the 13th International Conference on Advances in Computer Entertainment Technology* (New York, NY, USA, 2016-11-09) *(ACE '16)*. Association for Computing Machinery, 1–6. https://doi.org/10.1145/3001773.3001798

[4] Nikolaos Avouris and Nikoleta Yiannoutsou. 2012. A Review of Mobile Location-based Games for Learning across Physical and Virtual Spaces. *JUCS - Journal of Universal Computer Science* 18, 15 (2012), 2120–2142. Issue 15. https://doi.org/10.3217/jucs-018-15-2120

[5] David Benyon, Oli Mival, and Serkan Ayan. 2012. Designing Blended Spaces. In *Proceedings of the 26th Annual BCS Interaction Specialist Group Conference on People and Computers* (Birmingham, United Kingdom) *(BCS-HCI '12)*. 398–403.

[6] Ilene R. Berson. 2003. Grooming Cybervictims. *Journal of School Violence* 2, 1 (Jan. 2003), 5–18. https://doi.org/10.1300/J202v02n01_02

[7] Mark Bilandzic and Marcus Foth. 2012. A Review of Locative Media, Mobile and Embodied Spatial Interaction. 70, 1 (2012), 66–71. https://doi.org/10.1016/j.ijhcs.2011.08.004

[8] Mark Billinghurst. 2021. Grand Challenges for Augmented Reality. 2 (2021). https://www.frontiersin.org/articles/10.3389/frvir.2021.578080

Just Accepted

[9] Letizia Bollini and Daniele Begotti. 2017. The Time Machine. Cultural Heritage and the Geo-Referenced Storytelling of Urban Historical Metamorphose. In *Computational Science and Its Applications – ICCSA 2017* (Cham) *(Lecture Notes in Computer Science)*, Osvaldo Gervasi, Beniamino Murgante, Sanjay Misra, Giuseppe Borruso, Carmelo M. Torre, Ana Maria A.C. Rocha, David Taniar, Bernady O. Apduhan, Elena Stankova, and Alfredo Cuzzocrea (Eds.). Springer International Publishing, 239–251. https://doi.org/10.1007/978-3-319-62398-6_17

[10] Nigel Bond and John Falk. 2013. Tourism and identity-related motivations: why am I here (and not there)? *International Journal of Tourism Research* 15, 5 (2013), 430–442. https://doi.org/[10.1002/jtr.1886](https://doi.org/10.1002/jtr.1886)

[11] Matt Bower, Mark J. W. Lee, and Barney Dalgarno. 2017. Collaborative Learning across Physical and Virtual Worlds: Factors Supporting and Constraining Learners in a Blended Reality Environment. 48, 2 (2017), 407–430. https://doi.org/10.1111/bjet.12435

[12] Jonathan Broadbent and Patrizia Marti. 1997. Location Aware Mobile Interactive Guides: Usability Issues.. In *ICHIM*, Vol. 97. 88–98.

[13] Damien Brun, Stéphane Safin, Charles Gouin-Vallerand, and Sébastien George. 2020. Mixed Reality at Work: Health, Social and Ethical Implication. https://hal.science/hal-04033129

[14] Ben S Bunting, Jacob Hughes, and Tim Hetland. 2012. The player as author: Exploring the effects of mobile gaming and the location-aware interface on storytelling. *Future Internet* 4, 1 (2012), 142–160.

[15] Marcus Carter and Ben Egliston. 2020. Ethical Implications of Emerging Mixed Reality Technologies. (2020). https://doi.org/10.25910/5ee2f9608ec4d

[16] Ann Cavoukian. 2009. Privacy by Design. (2009).

[17] Thomas Chatzidimitris, Damianos Gavalas, and Despina Michael. 2016. SoundPacman: Audio Augmented Reality in Location-Based Games. In *2016 18th Mediterranean Electrotechnical Conference (MELECON)*. 1–6. https://doi.org/10.1109/MELCON.2016.7495414

[18] Shira Chess. 2014. Augmented Regionalism: Ingress as Geomediated Gaming Narrative. 17, 9 (2014), 1105–1117. https://doi.org/10.1080/1369118X.2014.881903

[19] Elizabeth F. Churchill. 2010. Today's Flâneur: From HCI to Place-Based Interaction and Human-Place Interaction. 17, 4 (2010), 62–66. https://doi.org/10.1145/1806491.1806507

[20] Doriana Cisternino, Laura Corchia, Valerio De Luca, Carola Gatto, Silvia Liaci, Liliana Scrivano, Anna Trono, and Lucio Tommaso De Paolis. 2021. Augmented Reality Applications to Support the Promotion of Cultural Heritage: The Case of the Basilica of Saint Catherine of Alexandria in Galatina. 14, 4 (2021), 47:1–47:30. https://doi.org/10.1145/3460657

[21] Tanguy Coenen, Lien Mostmans, and Kris Naessens. 2013. MuseUs: Case Study of a Pervasive Cultural Heritage Serious Game. 6, 2 (2013), 8:1–8:19. https://doi.org/10.1145/2460376.2460379

[22] Ashley Colley, Jacob Thebault-Spieker, Allen Yilun Lin, Donald Degraen, Benjamin Fischman, Jonna Häkkilä, Kate Kuehl, Valentina Nisi, Nuno Jardim Nunes, Nina Wenig, Dirk Wenig, Brent Hecht, and Johannes Schöning. 2017. The Geography of Pokémon GO: Beneficial and Problematic Effects on Places and Movement. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (New York, NY, USA) *(CHI '17)*. Association for Computing Machinery, 1179–1192. https://doi.org/10.1145/3025453.3025495

[23] Christine Cook, Juliette Schaafsma, and Marjolijn Antheunis. 2018. Under the Bridge: An in-Depth Examination of Online Trolling in the Gaming Context. *New Media & Society* 20, 9 (Sept. 2018), 3323–3340. https://doi.org/10.1177/1461444817748578

[24] Gemma San Cornelio and Elisenda Ardévol. 2011. Practices of Place-Making through Locative Media Artworks. 36, 3 (2011), 313–333. https://doi.org/10.1515/comm.2011.016

[25] Paul Coulton, Kate Lund, and Andrew Wilson. 2010. Harnessing Player Creativity to Broaden the Appeal of Location Based Games. In *Proceedings of the 24th BCS Interaction Specialist Group Conference (BCS '10)*. BCS Learning & Development Ltd., Swindon, GBR, 143–150.

[26] N. Davies, K. Cheverst, K. Mitchell, and A. Efrat. 2001. Using and determining location in a context-sensitive tour guide. *Computer* 34, 8 (Aug 2001), 35–41. https://doi.org/10.1109/2.940011

[27] Jonathan Dovey. 2016. Ambient literature: Writing probability. *Ubiquitous Computing, Complexity and Culture* (2016), 141–154.

[28] Thiago Falcão, Luiz Andrade, Emmanoel Ferreira, Paolo Bruni, Thiago Falcão, Luiz Andrade, Emmanoel Ferreira, and Paolo Bruni. 1. Locative Media and Playful Appropriations or How Electronic Games Help to Redefine the Meaning of Space. https://www.igi-global.com/gateway/chapter/www.igi-global.com/gateway/chapter/48351.

[29] S. Fazio and J. Turner. 2020. Bringing Empty Rooms to Life for Casual Visitors Using an AR Adventure Game: Skullduggery at Old Government House. 13, 4 (2020), 26:1–26:21. https://doi.org/10.1145/3418037

[30] Alessandro Febretti, Arthur Nishimoto, Terrance Thigpen, Jonas Talandis, Lance Long, J. D. Pirtle, Tom Peterka, Alan Verlo, Maxine Brown, Dana Plepys, Dan Sandin, Luc Renambot, Andrew Johnson, and Jason Leigh. 2013. CAVE2: A Hybrid Reality Environment for Immersive Simulation and Information Analysis. In *The Engineering Reality of Virtual Reality 2013*, Vol. 8649. SPIE, 9–20. https://doi.org/10.1117/12.2005484

[31] Rodrigo Firmino and Fabio Duarte. 2010. Manifestations and Implications of an Augmented Urban Life. 12 (2010), 27–34. https://doi.org/10.29173/irie266

[32] DW Gotterbarn, Bo Brinkman, Catherine Flick, Michael S Kirkpatrick, Keith Miller, Kate Vazansky, and Marty J Wolf. 2018. ACM Code of Ethics and Professional Conduct. (2018).

[33] Colin M. Gray, Yubo Kou, Bryan Battles, Joseph Hoggatt, and Austin L. Toombs. 2018. The Dark (Patterns) Side of UX Design. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. Association for Computing Machinery, New

Just Accepted

York, NY, USA, 1–14. https://doi.org/10.1145/3173574.3174108
[34] Bin Guo, Ryota Fujimura, Daqing Zhang, and Michita Imai. 2012. Design-in-Play: Improving the Variability of Indoor Pervasive Games. *Multimedia Tools and Applications* 59, 1 (July 2012), 259–277. https://doi.org/10.1007/s11042-010-0711-z
[35] Juho Hamari, Aqdas Malik, Johannes Koski, and Aditya Johri. 2019. Uses and Gratifications of Pokémon Go: Why Do People Play Mobile Location-Based Augmented Reality Games? *International Journal of Human–Computer Interaction* 35, 9 (May 2019), 804–819. https://doi.org/10.1080/10447318.2018.1497115
[36] Charlie Hargood, Mark Weal, and David Millard. 2018. The storyplaces platform: Building a web-based locative hypertext system. In *HT '18 Proceedings of the 29th ACM Conference on Hypertext and Social Media*. ACM, 128–135. https://eprints.soton.ac.uk/421122/
[37] Olli I. Heimo, Kai K. Kimppa, Seppo Helle, Timo Korkalainen, and Teijo Lehtonen. 2014. Augmented Reality - Towards an Ethical Fantasy?. In *2014 IEEE International Symposium on Ethics in Science, Technology and Engineering*. 1–7. https://doi.org/10.1109/ETHICS.2014.6893423
[38] Joshua Hendrickse, Laura M. Arpan, Russell B. Clayton, and Jessica L. Ridgway. 2017. Instagram and College Women's Body Image: Investigating the Roles of Appearance-Related Comparisons and Intrasexual Competition. *Computers in Human Behavior* 74 (Sept. 2017), 92–100. https://doi.org/10.1016/j.chb.2017.04.027
[39] Sonja M. Hyrynsalmi, Minna M. Rantanen, and Sami Hyrynsalmi. 2021. Towards Ethical Guidelines of Location-Based Games: Challenges in the Urban Gaming World. In *Software Business* (Cham) *(Lecture Notes in Business Information Processing)*, Eriks Klotins and Krzysztof Wnuk (Eds.). Springer International Publishing, 134–142. https://doi.org/10.1007/978-3-030-67292-8_10
[40] Jonna Häkkilä, Meri-Tuulia Forsman, and Ashley Colley. 2018. Navigating the Graveyard: Designing Technology for Deathscapes. In *Proceedings of the 17th International Conference on Mobile and Ubiquitous Multimedia* (New York, NY, USA) *(MUM '18)*. Association for Computing Machinery, 199–204. https://doi.org/10.1145/3282894.3282912
[41] Debora Jeske and Alecia M. Santuzzi. 2015. Monitoring What and How: Psychological Implications of Electronic Performance Monitoring. *New Technology, Work and Employment* 30, 1 (2015), 62–78. https://doi.org/10.1111/ntwe.12039
[42] Callum Jones, Verity Trott, and Scott Wright. 2020. Sluts and Soyboys: MGTOW and the Production of Misogynistic Online Harassment. *New Media & Society* 22, 10 (Oct. 2020), 1903–1921. https://doi.org/10.1177/1461444819887141
[43] Eileen Joy, Virginia Braun, and Victoria Clarke. 2023. Doing Reflexive Thematic Analysis: A Reflexive Account. (Jan. 2023).
[44] Timothy Hyungsoo Jung, Hyunae Lee, Namho Chung, and prefix=tom useprefix=true family=Dieck, given=M. Claudia. 2018. Cross-Cultural Differences in Adopting Mobile Augmented Reality at Cultural Heritage Tourism Sites. 30, 3 (2018), 1621–1645. https://doi.org/10.1108/IJCHM-02-2017-0084
[45] Vlasios Kasapakis, Damianos Gavalas, and Nikos Bubaris. 2013. Pervasive Games Research: A Design Aspects-Based State of the Art Report. In *Proceedings of the 17th Panhellenic Conference on Informatics* (New York, NY, USA) *(PCI '13)*. Association for Computing Machinery, 152–157. https://doi.org/10.1145/2491845.2491874
[46] Peter Kiefer, Sebastian Matyas, and Christoph Schlieder. 2006. Systematically exploring the design space of location-based games. In *4th International Conference on Pervasive Computing*. Citeseer, 183–190.
[47] Andrew King, Faisal Kaleem, and Khaled Rabieh. 2020. A Survey on Privacy Issues of Augmented Reality Applications. In *2020 IEEE Conference on Application, Information and Network Security (AINS)*. 32–40. https://doi.org/10.1109/AINS50155.2020.9315127
[48] Andreas Kotsios. 2015. Privacy in an Augmented Reality. 23, 2 (2015), 157–185. https://doi.org/10.1093/ijlit/eav003
[49] Yuan Li. 2012. Theories in Online Information Privacy Research: A Critical Review and an Integrated Framework. *Decision Support Systems* 54, 1 (Dec. 2012), 471–481. https://doi.org/10.1016/j.dss.2012.06.010
[50] Fan Liang, Vishnupriya Das, Nadiya Kostyuk, and Muzammil M. Hussain. 2018. Constructing a Data-Driven Society: China's Social Credit System as a State Surveillance Infrastructure. *Policy & Internet* 10, 4 (2018), 415–453. https://doi.org/10.1002/poi3.183
[51] María Teresa Linaza, Aitor Gutierrez, and Ander García. 2013. Pervasive Augmented Reality Games to Experience Tourism Destinations. In *Information and Communication Technologies in Tourism 2014* (Cham), Zheng Xiang and Iis Tussyadiah (Eds.). Springer International Publishing, 497–509. https://doi.org/10.1007/978-3-319-03973-2_36
[52] Sue Long, Rob Kooper, Gregory D. Abowd, and Christopher G. Atkeson. 1996. Rapid Prototyping of Mobile Context-aware Applications: The Cyberguide Case Study. In *Proceedings of MobiCom '96* (Rye, New York, USA). ACM, New York, NY, USA, 97–107. https://doi.org/10.1145/236387.236412
[53] Anders Sundnes Løvlie. 2009. Poetic Augmented Reality: Place-bound Literature in Locative Media. In *Proceedings of the 13th International MindTrek Conference: Everyday Life in the Ubiquitous Era* (Tampere, Finland) *(MindTrek '09)*. ACM, New York, NY, USA, 19–28.
[54] Anders Sundnes Løvlie. 2011. Annotative Locative Media and G-P-S: Granularity, Participation, and Serendipity. *Computers and Composition* 28, 3 (Sept. 2011), 246–254. https://doi.org/10.1016/j.compcom.2011.07.006
[55] Vanessa De Luca and Maresa Bertolo. 2012. Urban Games to Design the Augmented City. 6, 1 (2012), 71–83. Issue 1. https://doi.org/10.7557/23.6139
[56] Anders Sundnes Løvlie, Karin Ryding, Jocelyn Spence, Paulina Rajkowska, Annika Waern, Tim Wray, Steve Benford, William Preston, and Emily Clare-Thorn. 2021. Playing Games with Tito: Designing Hybrid Museum Experiences for Critical Play. 14, 2 (2021), 16:1–16:26. https://doi.org/10.1145/3446620

Just Accepted

[57] Rainer Malaka, Kerstin Schneider, and Ursula Kretschmer. 2004. Stage-based augmented edutainment. In *International Symposium on Smart Graphics*. Springer, 54–65.

[58] Conor McGarrigle. 2010. The Construction of Locative Situations: Locative Media and the Situationist International, Recuperation or Redux? 21, 1 (2010), 55–62. https://doi.org/10.1080/14626261003652057

[59] Lee McIntyre. 2018. *Post-Truth*. MIT Press.

[60] Katina Michael and Roger Clarke. 2012. Location Privacy Under Dire Threat As Uberveillance Stalks The Streets. *Precedent (Focus on Privacy/FOI)* 108 (2012).

[61] Jerry Michalski. 2007. Ethical Dangers of Mobile Persuasion. In *Mobile Persuasion: 20 Perspectives on the Future of Behavior Change*, B. J. Fogg and Dean Eckles (Eds.). Stanford Captology Media, Standford, Calif.

[62] Paul Milgram and Fumio Kishino. 1994. A Taxonomy of Mixed Reality Visual Displays. 77, 12 (1994), 1321–1329.

[63] David Millard and Tom Blount. 2023. Loose Canon: Where Is the Shared History for Mixed Reality Visit Systems?. In *Narrative and Hypertext Workshop 2023 (05/09/23 - 05/09/23)*.

[64] David Millard, Heather Packer, Yvonne Howard, and Charlie Hargood. 2020. The Balance of Attention: The Challenges of Creating Locative Cultural Storytelling Experiences. 13, 4 (2020). Issue 4. https://doi.org/10.1145/3404195

[65] David E. Millard, Sarah Hewitt, Kieron O'Hara, Heather Packer, and Neil Rogers. 2004. The Unethical Future of Mixed Reality Storytelling. In *Proceedings of the 8th International Workshop on Narrative and Hypertext* (New York, NY, USA) *(NHT '19)*. Association for Computing Machinery, 5–8. https://doi.org/10.1145/3345511.3349283

[66] Cosmin Munteanu, Heather Molyneaux, Wendy Moncur, Mario Romero, Susan O'Donnell, and John Vines. 2015. Situational Ethics: Re-thinking Approaches to Formal Ethics Requirements for Human-Computer Interaction. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. Association for Computing Machinery, New York, NY, USA, 105–114. https://doi.org/10.1145/2702123.2702481

[67] Erica L. Neely. 2019. Augmented Reality, Augmented Ethics: Who Has the Right to Augment a Particular Physical Space? 21, 1 (2019), 11–18. https://doi.org/10.1007/s10676-018-9484-2

[68] Rui Nóbrega, João Jacob, António Coelho, João Ribeiro, Jessika Weber-Sabil, and Soraia Ferreira. 2018. Leveraging Pervasive Games for Tourism: An Augmented Reality Perspective. 9 (2018), 1–14. https://doi.org/10.4018/IJCICG.2018010101

[69] Kieron O'Hara. 2016. The Seven Veils of Privacy. *IEEE Internet Computing* 20, 2 (March 2016), 86–91. https://doi.org/10.1109/MIC.2016.34

[70] Mohd Kamal Othman, Shaziti Aman, Nurfarahani Norman Anuar, and Ikram Ahmad. 2021. Improving Children's Cultural Heritage Experience Using Game-based Learning at a Living Museum. 14, 3 (2021), 39:1–39:24. https://doi.org/10.1145/3453073

[71] Heather Packer, Charlie Hargood, Yvonne Howard, Petros Papadopoulos, and David Millard. 2017. Developing a Writer's Toolkit for Interactive Locative Storytelling, Vol. 10690. Springer, 63–74. https://doi.org/10.1007/978-3-319-71027-3_6

[72] S. Pase. 2012. Ethical Considerations in Augmented Reality Applications.

[73] Erick Ramirez. 2021. *The Ethics of Virtual and Augmented Reality: Building Worlds*. Taylor & Francis Group.

[74] Erick Jose Ramirez and Scott LaBarge. 2018. Real Moral Problems in the Use of Virtual Reality. *Ethics and Information Technology* 20, 4 (Dec. 2018), 249–263. https://doi.org/10.1007/s10676-018-9473-5

[75] Lambèr Royakkers, Dhoya Snijders, and prefix=van useprefix=true family=Est, given=Rinie. 2022. The Ten Commandments for Responsible Augmented Reality. In *New Trends in Disruptive Technologies, Tech Ethics and Artificial Intelligence* (Cham) *(Advances in Intelligent Systems and Computing)*, prefix=de useprefix=true family=Paz Santana, given=Juan F., prefix=de la useprefix=true family=Iglesia, given=Daniel H., and Alfonso José López Rivero (Eds.). Springer International Publishing, 121–132. https://doi.org/10.1007/978-3-030-87687-6_13

[76] Irene Rubino, Claudia Barberis, Jetmir Xhembulla, and Giovanni Malnati. 2015. Integrating a Location-Based Mobile Game in the Museum Visit: Evaluating Visitors' Behaviour and Learning. 8, 3 (2015), 1–18. https://doi.org/10.1145/2724723

[77] Lucia Santaella. 2011. Mobile and Locative Media: In between Thanatos and Eros. In *ICTs for Mobile and Ubiquitous Urban Infrastructures: Surveillance, Locative Media and Global Networks*. IGI Global, 294–311. https://doi.org/10.4018/978-1-60960-051-8.ch017

[78] Kyarash Shahriari and Mana Shahriari. 2017. IEEE Standard Review — Ethically Aligned Design: A Vision for Prioritizing Human Wellbeing with Artificial Intelligence and Autonomous Systems. In *2017 IEEE Canada International Humanitarian Technology Conference (IHTC)*. 197–201. https://doi.org/10.1109/IHTC.2017.8058187

[79] Kieron Sheehy, Helena Garcia Carrizosa, Jonathan Rix, Jane Seale, and Simon Hayhoe. 2019. Inclusive Museums and Augmented Reality. Affordances, Participation, Ethics and Fun. 12, 4 (2019), 67–85. Issue 4. https://doi.org/10/Submission%20Inclusive%20museums%20and%20augmented%20reality%20copy.docx

[80] John Shen, Siddharth Ghatti, Nate Ryan Levkov, Haiying Shen, Tanmoy Sen, Karen Rheuban, Kyle Enfield, Nikki Reyer Facteau, Gina Engel, and Kim Dowdell. 2022. A Survey of COVID-19 Detection and Prediction Approaches Using Mobile Devices, AI, and Telemedicine. *Frontiers in Artificial Intelligence* 5 (Dec. 2022), 1034732. https://doi.org/10.3389/frai.2022.1034732

[81] Miguel Sicart. 2017. Reality Has Always Been Augmented: Play and the Promises of Pokémon GO. *Mobile Media & Communication* 5, 1 (Jan. 2017), 30–33. https://doi.org/10.1177/2050157916677863

Just Accepted

[82] Michaela Slussareff and Petra Boháčková. 2016. Students as Game Designers vs. 'Just' Players: Comparison of Two Different Approaches to Location-Based Games Implementation into School Curricula. (2016), 284–297. https://doi.org/10.1344/der.2016.29.284-297

[83] Claudia Soria. 2015. Towards a Notion of "Digital Language Diversity". In *Linguistic and Cultural Diversity in Cyberspace. Proceedings of the 3rd International Conference (Yakutsk, Russian Federation, 30 June–3 July 2014). Moscow: Interregional Library Cooperation Centre.* 111.

[84] Sarah Spiekermann and Lorrie Faith Cranor. 2009. Engineering Privacy. *IEEE Transactions on Software Engineering* 35, 1 (Jan. 2009), 67–82. https://doi.org/10.1109/TSE.2008.88

[85] Ulrike Spierling, Peter Winzer, and Erik Massarczyk. 2017. Experiencing the Presence of Historical Stories with Location-Based Augmented Reality. In *Interactive Storytelling* (Cham) *(Lecture Notes in Computer Science)*, Nuno Nunes, Ian Oakley, and Valentina Nisi (Eds.). Springer International Publishing, 49–62. https://doi.org/10.1007/978-3-319-71027-3_5

[86] T. L. S. Sprigge. 1984. Non-human Rights: An Idealist Perspective. *Inquiry* 27, 1-4 (Jan. 1984), 439–461. https://doi.org/10.1080/00201748408602029

[87] Kay M. Stanney, Hannah Nye, Sam Haddad, Kelly S. Hale, Christina K. Padron, and Joseph V. Cohn. 2021. Extended Reality (Xr) Environments. In *HANDBOOK OF HUMAN FACTORS AND ERGONOMICS*. John Wiley & Sons, Ltd, 782–815. https://doi.org/10.1002/9781119636113.ch30

[88] Venera Tomaselli, Giulio Giacomo Cantone, and Valeria Mazzeo. 2022. Review Bomb: On the Gamification of the Ideological Conflict. In *Handbook of Research on Cross-Disciplinary Uses of Gamification in Organizations*. IGI Global, 334–354. https://doi.org/10.4018/978-1-7998-9223-6.ch016

[89] Silvia Torsi, Carmelo Ardito, and Cristina Rebek. 2020. An Interactive Narrative to Improve Cultural Heritage Experience in Elementary School Children. 13, 3 (2020), 22:1–22:14. https://doi.org/10.1145/3382771

[90] Stavroula Tzima, Georgios Styliaras, and Athanasios Bassounas. 2021. Augmented Reality in Outdoor Settings: Evaluation of a Hybrid Image Recognition Technique. 14, 3 (2021), 31:1–31:17. https://doi.org/10.1145/3439953

[91] Silviu Vert and Radu Vasiu. 2014. Relevant Aspects for the Integration of Linked Data in Mobile Augmented Reality Applications for Tourism. In *Information and Software Technologies (Communications in Computer and Information Science)*, Giedre Dregvaite and Robertas Damasevicius (Eds.). Springer International Publishing, Cham, 334–345. https://doi.org/10.1007/978-3-319-11958-8_27

[92] Jose Ricardo Mello Viana, Nayane Ponte Viana, Fernando Antonio Mota Trinta, and prefix=de useprefix=false family=Carvalho, given=Windson Viana. 2014. A Systematic Review on Software Engineering in Pervasive Games Development. In *2014 Brazilian Symposium on Computer Games and Digital Entertainment*. 51–60. https://doi.org/10.1109/SBGAMES.2014.16

[93] Mark J Weal, Don Cruickshank, Danius T Michaelides, David E Millard, David C De Roure, Katherine Howland, and Geraldine Fitzpatrick. 2007. A card based metaphor for organising pervasive educational experiences. In *PerCom Workshops' 07*. IEEE, 165–170.

[94] Janis Wolak, Kimberly J. Mitchell, and David Finkelhor. 2007. Does Online Harassment Constitute Bullying? An Exploration of Online Harassment by Known Peers and Online-Only Contacts. *Journal of Adolescent Health* 41, 6, Supplement (Dec. 2007), S51–S58. https://doi.org/10.1016/j.jadohealth.2007.08.019

[95] Marty J. Wolf, Frances Grodzinsky, and Keith Miller. 2016. Augmented Reality All around Us: Power and Perception at a Crossroads. *ACM SIGCAS Computers and Society* 45, 3 (Jan. 2016), 126–131. https://doi.org/10.1145/2874239.2874257

[96] Michael Zoellner, Jens Keil, Timm Drevensek, and Harald Wuest. 2009. Cultural Heritage Layers: Integrating Historic Media in Augmented Reality. In *2009 15th International Conference on Virtual Systems and Multimedia*. 193–196. https://doi.org/10.1109/VSMM.2009.35

[97] Matthew Zook, Mark Graham, and Andrew Boulton. 2015. Crowd-Sourced Augmented Realities: Social Media and the Power of Digital Representation. In *Mediated Geographies and Geographies of Media*, Susan P. Mains, Julie Cupples, and Chris Lukinbeal (Eds.). Springer Netherlands, 223–240. https://doi.org/10.1007/978-94-017-9969-0_14

[98] Shoshana Zuboff. 2019. Surveillance Capitalism and the Challenge of Collective Action. *New Labor Forum* 28, 1 (Jan. 2019), 10–29. https://doi.org/10.1177/1095796018819461

Received 15 December 2023; revised 30 April 2024; accepted 5 June 2024

Just Accepted